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Socioeconomic inequalities of cardiovascular risk factors among manufacturing employees in the Republic of Ireland: A cross-sectional study

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ABSTRACT

Objectives: To explore socioeconomic differences in four cardiovascular disease risk factors (overweight/obesity, smoking, hypertension, height) among manufacturing employees in the Republic of Ireland (ROI). *Methods*: Cross-sectional analysis of 850 manufacturing employees aged 18–64 years. Education and job position served as socioeconomic indicators. Group-specific differences in prevalence were assessed with the Chi-squared test. Multivariate regression models were explored if education and job position were independent predictors of the CVD risk factors. Cochran–Armitage test for trend was used to assess the presence of a social gradient. *Results*: A social gradient was found across educational levels for smoking and height. Employees with the highest education were less likely to smoke compared to the least educated employees (OR 0.2, [95% CI 0.1–0.4]; $p < 0.001$). Lower educational attainment was associated with a reduction in mean height. Non-linear differences were found in both educational level and job position for obesity/overweight. Managers were more than twice as likely to be overweight or obese relative to those employees in the lowest job position (OR 2.4 [95% CI 1.3–4.6]; $p = 0.008$). *Conclusion*: Socioeconomic inequalities in height, smoking and overweight/obesity were highlighted within a sub-section of the working population in ROI.

Introduction

Socioeconomic inequalities in health are a major population health concern. It places a substantial financial burden on European economies (Mackenbach et al., 2011). Similar to other chronic illnesses, cardiovascular disease (CVD) follows a social gradient in both population-based and occupational based studies (Marmot et al., 1978; Mulcahy et al., 1984; Kaplan and Keil, 1993; Mackenbach et al., 2000; Barry et al., 2001; Balanda and Wilde, 2001; Rosengren et al., 2009). This graded pattern is evident at each rank of the socioeconomic hierarchy; not just at the point of severe deprivation (Adler et al., 1994; Marmot, 2005). The burden of CVD has steadily declined in Europe over the past number of years (Mackenbach and Bakker, 2003). However, in Western Europe the prevalence of CVD has decreased more rapidly in groups with a higher socioeconomic status and inequalities along the social gradient have increased (Mackenbach and Bakker, 2003).

Established risk factors for CVD, such as hypertension, smoking, height and obesity have also been shown to follow the social gradient (Kaplan and Keil, 1993; Marmot et al., 1978, 1991; Mulcahy et al., 1984; Morgan et al., 2008; Winkleby et al., 1992a). Combinations of these risk factors have explained 12%–54% of the socioeconomic inequalities in CVD (Marmot et al, 1978, 1991; Macintyre, 1997; Laaksonen et al., 2008; van Oort et al., 2005). It has been suggested that individuals who are classified at the lower end of the socioeconomic hierarchy are more resistant to changing risk behaviours than their more advantaged counterparts (Winkleby et al., 1994). From an international perspective, the social gradient in health and risk factors for CVD has been mainly demonstrated in general population studies and less in occupational studies, with the exception of Whitehall (Marmot et al., 1978, 1991) which was limited to civil servants. Occupational samples differ from the general population as they usually do not include poor people, may be healthier and have a higher educational level.

Therefore, the aim of this study was to investigate socioeconomic inequalities in overweight/obesity, smoking, hypertension and height using employees from four large multi-national manufacturing companies in the Republic of Ireland (ROI). We hypothesize that: (1) educational attainment and job position will be independent predictors for CVD risk factors and (2) a social gradient will be observed; with those from the lowest socioeconomic groups being more likely to be overweight/obese, smokers, hypertensive and shorter in height relative to their socially higher counterparts.

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Methods

Baseline data (Feb–July 2013) from the Food Choice at Work (FCW) study were acquired to examine whether socioeconomic inequalities of cardiovascular risk factors were evident among manufacturing employees. The FCW study is a cluster controlled trial (trial registration ISRCTN35108237) involving four multinational manufacturing workplaces in Cork, ROI. The FCW study measures the effectiveness and cost-effectiveness of complex workplace dietary interventions that include environmental dietary modifications alone or in combination with nutrition education. The present study carried out cross-sectional analysis before the FCW study intervention was implemented.

Study population

The sample size for the FCW study was powered at 80% to detect a decrease in BMI by 1 kg/m^2 and a 2 g average fall in dietary salt intake between the control and intervention groups following delivery of the interventions. Eligibility criteria for participants included all permanent, full-time employees who purchased and consumed at least one main meal at work on a daily basis. A randomly selected sample of 850 employees (aged 18–64 years) were recruited via random number allocation software and invited to participate by email or telephone. A detailed account of the study's protocol is described elsewhere (Geaney et al., 2013). Participants that did not complete a socio-demographic and lifestyle questionnaire and a physical assessment were excluded from the analysis.

Data collection

All physical assessments (height, weight and blood pressure) were conducted by trained research assistants in a standardised manner as per the study protocol (Geaney et al., 2013). Questionnaires were self-completed in electronic or hard copy format. All data collection took place during the participants' working hours (break times excluded).

Socioeconomic status (SES) indicators

Highest level of completed education and job position served as the indicators for SES. Education was transformed into a four level variable: completed high school or less, certificate/diploma, basic university degree and higher university degree. Job position was classified as: manager, supervisor and general staff.

CVD risk factors

The four CVD risk factors explored were defined as the dependant variables. Current smoking status was determined by the question "*Do you now smoke*" (Yes or No). Participants' body weight (kg) was taken on a calibrated weighing scale (Tanita WB100MA) and height (cm) was measured using a portable Seca Leicester height/length measure. Body mass index (BMI) (kg/m^2) was defined as: underweight/healthy (<24.99 kg/m^2); overweight (25.00–29.99 kg/m^2) and obese (>30.00 kg/m^2) in accordance with international classifications (World Health Organisation, 2013). Subsequently, to indicate the presence of overweight or obesity a BMI of ≥25 kg/m^2 was coded as 'yes' and ≤24.99 kg/m^2 as 'no'. Blood pressure (BP) was measured three times on the right arm after at least 10 min of rest in a seated position using a calibrated digital blood pressure monitor (Omron M7). The average of the last two BP readings was used for analysis. Hypertension was defined as a systolic reading of ≥140 mm Hg and/or a diastolic reading of ≥90 mm Hg (American Heart Association, 2012). Participants who had a self-reported previous diagnosis of high blood pressure were also classified as hypertensive.

Other variables

Other variables of interest (accommodation, marital status and existing medical conditions) were self-reported via a Health, Lifestyle and Food Questionnaire (HLFQ). These were considered as potential confounding factors because of their possible association with CVD risk factors and each of the socioeconomic indicators (Marmot et al., 1991; Nishi et al., 2004; Gupta et al., 2012; Martikainen et al., 2001).

Statistical analysis

All analyses were carried out using STATA version 12 (StataCorp, College Station, TX, US). In accordance with standard research methodology, the level of statistical significance was 0.05. A demographic profile of the study sample was generated to give an overview of baseline characteristics. The prevalence of each categorical CVD risk factor was generated according to each SES indicator. Job position was not stratified by gender due to the small sample size in the higher categories. Differences in proportions were tested by a Chi-squared test and a one-way ANOVA test was conducted to compare height in each of the SES groups (educational level and job position, respectively). Three multivariate logistic regression models were utilised to establish if educational attainment and job position were independent predictors for each dichotomised CVD risk factor (smoking, overweight/obesity, and hypertension). Height (cm) was analysed using multivariate linear regression. All analyses were adjusted for age, gender, house ownership, marital status and medical condition. Regardless of significance in univariate analysis, all potential confounders were considered in accordance with other research in this area (Marmot et al., 1991; Nishi et al., 2004; Gupta et al., 2012; Martikainen et al., 2001). The lowest socioeconomic group served as the reference category in each model. Education and job position were potentially correlated so the variance inflation factor (VIF) was examined to assess the presence of collinearity; a VIF of >10 indicated collinearity. The odds ratio (OR) or beta coefficient (β), respective 95% confidence interval and associated p values were reported. The Cochran–Armitage test for trend was utilised to identify a social gradient.

Ethical approval

Ethical approval for the FCW study was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals in the Republic of Ireland in March 2013. All participants provided written informed consent before data collection commenced.

Results

In total, 883 individuals were recruited for the Food Choice at Work study, 19 participants were excluded as they did not attend a physical assessment and a further 14 were excluded because the HLFQ was unanswered. Therefore, the sample comprised of 850 adults; 586 males (68%) and 264 females (31%) (workplace A: 111 (72% response rate), workplace B: 226 (71% response rate), workplace C: 400 (61% response rate), and workplace D: 113 (91% response rate)). The distribution of baseline characteristic for the total population and by gender is illustrated in Table 1.

The distribution of each CVD risk factor, according to educational attainment and job position is shown in Table 2. For educational attainment the most consistent trends were found for smoking and height, for both men and women. Men who had attained the highest level of education were 5 cm taller relative to those in the lowest educational group (174 cm vs. 179 cm; $p < 0.001$). In men, 26% in the lowest education group smoked compared to 11% in the highest ($p < 0.001$). Among women, 37% of the least educated women were current smokers relative to 8% who had a higher university degree ($p = 0.003$). A higher percentage of male employees from the lowest education category were

Table 1
Baseline characteristics of Food Choice at Work study participants by gender, ROI (2013).

	Men (n = 586)	Women (n = 264)	p	Total (n = 850)
Age (years)[a]	39 (3.9)	38.1 (8.3)	0.1	38.7 (8)
Ethnicity[b]				
White Irish	533 (90)	233 (88)		763 (90)
Other	55 (9)	30 (11)	0.5	85 (10)
Married[b]				
Yes	377 (64.4)	122 (46.2)		499 (59)
No	208 (35.6)	142 (46.2)	0.000	350 (41.2)
Housing[b]				
Rented/other	158 (27.1)	79 (30)		237 (28)
Owned	425 (72.9)	184 (70)	0.4	609 (71.9)
Education[b]				
High school/less	109 (19)	87 (33)		196 (23)
Certificate/diploma	151 (26)	74 (28)		225 (27)
Basic degree	203 (35)	55 (21)		258 (20)
Higher degree	123 (21)	48 (18)	0.000	171 (20)
Job position[b]				
General staff	432 (75.1)	225 (85.8)		657 (78)
Supervisor	66 (11.4)	22 (8.4)		89 (10.5)
Manager	77 (13.3)	15 (5.7)	0.000	92 (11)
Current smoker[b]				
Yes	79 (13.3)	64 (24.3)		143 (16.9)
No	504 (86.5)	199 (75.6)	0.000	703 (82)
Height (cm)[a]	177 (6.8)	163 (6.3)	0.000	172 (9.2)
Weight (kg)[a]	87 (12.1)	70 (14.5)	0.000	81 (15.1)
BMI (kg/m^2)[a]	27 (3.7)	26.2 (5)	0.000	27 (4.2)
BMI status[b]				
Normal	134 (23)	116 (44)		250 (29.4)
Overweight	318(54.4)	97 (36.7)		415 (48.8)
Obese	133 (22.7)	51 (19.3)	0.000	184 (21.6)
Systolic (mm Hg)[a]	125 (13)	111 (13.6)	0.000	121 (14.7)
Diastolic (mm Hg)[a]	76 (9.1)	71.5(9.6)	0.000	74 (9.5)
Hypertension[b]				
Yes	135 (23)	32 (13)		167 (19.6)
No	451 (77)	232 (87)	0.000	683 (80.3)
Medical condition[b]				
Yes	186 (31.7)	58 (21.9)		244 (28.1)
No	400 (68.2)	206 (78)	0.27	606 (71.3)

Data are [a]mean (SD) or [b]n (%).

hypertensive relative to those with a higher university degree (32% vs. 16%; p = 0.03).

There were no linear trends for obesity/overweight and hypertension. Among women, the prevalence of overweight/obesity was significantly higher in those at the lowest end of the education scale compared to those at the highest levels (69% vs. 61% vs. 38% vs. 58%; p = 0.004). Similar to smoking, the proportion of hypertensive men decreased as levels of education increased. Male employees who had the least education had a higher prevalence of hypertension compared to those with the highest.

In relation to the pattern of CVD risk factors by job position, no significant linear trend could be identified, however a significantly higher percentage of managers were overweight or obese compared to employees in the two lower job positions. The prevalence of this risk factor was 15% higher (70% vs. 85%; p = 0.003) in managers relative to employees who were not supervisors or managers.

Results from multivariate regression analysis are shown in Table 3. Multicollinearity was not found between variables (VIF < 10). In the fully adjusted logistic regression model, education was an independent predictor of overweight/obesity, smoking, hypertension and height. A non-linear trend was observed for overweight/obesity and hypertension (trend p > 0.05). Employees with a basic university degree were 40% less likely to be overweight or obese when compared to employees with the lowest level of educational attainment (OR 0.6 [95% CI 0.4–0.8]; p = 0.01). An inverse linear relationship between smoking and education was observed; as educational level increased the odds of smoking decreased (trend p = 0.02). Employees with a higher university degree were 80% less likely to smoke compared to the least educated employees (OR 0.2 [95% CI 0.1–0.4]; p < 0.001). The odds of hypertension were reduced in those who had a certificate/diploma compared to those who had an education of high school or less (OR 0.6 [95% CI 0.3–0.9]; p = 0.03). There was a clear significant difference in mean height between education groups and the difference linearly increased as educational attainment increased (trend p = 0.01). Job position was an independent predictor of overweight/obesity. After taking all variables into account, managers were nearly 2.5 times more likely to be overweight/obese relative to those employees in the lowest job position (OR 2.4 [95% CI 1.3–4.6]; p = 0.008).

Table 2
Prevalence of CVD risk factors among Food Choice at Work study participants by each SES indicator, ROI (2013).

SES indicator	CVD risk factors			
	Height cm[a]	Overweight n (%)	Smoking n (%)	Hypertension n (%)
Education				
Males (n = 586)				
High school/less	174 (7.6)[b]	84 (77)	28 (26)[b]	35 (32)[b]
Certificate/diploma	176 (6)[b]	127 (84)	19 (13)[b]	31 (21)[b]
Basic degree	178 (6.8)[b]	147 (72)	26 (13)[b]	44 (22)[b]
Higher degree	179 (7.2)[b]	90 (73)	14 (11)[b]	20 (16)[b]
Females (n = 264)				
High school/less	162 (150–165)[b]	60 (69)[b]	32 (37)[b]	15 (17)
Certificate/diploma	164 (155–175)[b]	45 (61)[b]	19 (26)[b]	9 (13)
Basic degree	164 (160–172)[b]	21 (38)[b]	12 (22)[b]	4 (7)
Higher degree	163 (160–171)[b]	28 (58)[b]	4 (8)[b]	5 (11)
Job position				
Total (n = 850)				
Lowest	173 (150–195)[b]	641(70)[b]	126(19)	122(19)
Supervisor	176 (150–190)[b]	75 (64)[b]	18 (20)	19 (22)
Manager	175 (155–180)[b]	83 (85)[b]	10 (10)	22 (23)

[a] Male = mean and standard deviation; female and job position = median with associated lower and upper quartile values.
[b] p value difference < 0.05.

Discussion

We found mixed evidence for our hypothesis of a gradient in CVD risk factors by education and job position. Consistent with previous research, employees who had completed high school or less were more likely to be overweight/obese, hypertensive and shorter in height than those employees in the higher education strata. This indicates that the least educated had a higher CVD risk profile; a finding which has been previously highlighted in the general Irish population (Mulcahy et al., 1984). In accordance with previous research (Winkleby et al., 1992b,1992b; Bobak et al., 1999; Nishi et al., 2004; Yu et al., 2000; Mackenbach et al., 2008; Layte and Whelan, 2008; Gupta et al., 2012), a social gradient was observed for smoking. In this study, employees with a higher university degree were 80% less likely to smoke relative to those employees who had completed high school (OR 0.2 [95% CI 0.1–0.4]; p = 0.000). These figures suggest that, similar to other northern European countries, the Republic of Ireland is in the final stage of a smoking epidemic; the overall prevalence of smoking has decreased but it is more common in lower socio-economic groups (Lopez et al., 1994; Alves et al., 2012). Contrary to our expectation, job position was not an independent predictor of smoking.

A social gradient was also observed among education groups in mean height. Results from the multivariate linear regression model were in line with existing literature; individuals with the least education are shorter in height relative to those with the highest education (Bobak et al., 1999; Meyer and Selmer, 1999; Magnusson et al., 2006) potentially due to adverse environmental exposure during intrauterine life (Barker, 1997) or during childhood that affected growth. Results for overweight/obesity did not follow the expected linear gradient. Nevertheless, those with a basic university degree were less likely to have an unhealthy BMI relative to those who had completed high school or less (OR 0.6 [95% CI 0.4–0.8], p = 0.01). Managers were 2.5 times as likely to

Table 3
Results from multivariate regression analysis exploring independent predictors in CVD risk factors in Food Choice at Work study participants, ROI (2013).

	Overweight/obesity		Smoking		Hypertension		Height (cm)	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	β (95% CI)	p
Age (years)	1.02	0.1	0.9	0.6	1.05 (1.05–1.1)	0.000	−0.1 (−0.2, 0.05)	0.000
Gender								
Male	1		1		1		1	
Female	0.4 (0.3–0.5)	0.000	1.9 (1.6–2.8)	0.6	0.4	0.000	−13.3 (−14.4, −12.4)	0.000
Educational level								
High school/less	1		1		1		1	
Diploma/certificate	1.1 (0.7–1.7)	0.8	0.5 (0.3–0.8)	0.007[a]	0.6 (0.3–0.9)	0.03	1.3 (0.1–2.6)	0.04[a]
Primary degree	0.6 (0.4–0.8)	0.01	0.4 (0.27–0.7)	0.003[a]	0.8 (0.4–1.3)	0.3	3.0 (1.72–4.3)	0.000[a]
Postgraduate	0.7 (0.4–1.2)	0.2	0.2 (0.1–0.4)	0.000[a]	0.6 (0.3–1.0)	0.05	3.2 (1.8–4.5)	0.000[a]
Job position								
General staff	1		1		1			
Supervisor	0.9 (0.5–1.5)	0.7	1.4 (0.8–2.5)	0.9	1.4 (0.8–2.6)	0.8	0.3 (−1.2–1.7)	0.4
Manager	2.4 (1.3–4.6)	0.008	0.9 (0.4–2.0)	0.3	0.9 (0.5–1.7)	0.2	0.6 (−.9–2.1)	0.7
Owned house								
No	1		1		1		1	
Yes	1.5 (0.9–2.1)	0.05	0.6 (0.4–0.9)	0.01	0.8 (0.3–1.8)	0.1	−0.06 (−1.2–1.03)	0.9
Married								
No	1		1		1		1	
Yes	1.01 (0.7–1.5)	0.06	1.4 (0.9–2.2)	0.09	0.7 (0.9–2.1)	0.06	0.009 (−1.0−1.03)	0.9
Medical condition								
No	1				1		1	
Yes	1.7 (1.1–2.5)	0.01	0.8 (0.5–1.2)	0.2	0.7 (0.4–1.1)	0.1	−1.4 (−2.4, −0.3)	0.009

[a] Trend $p < 0.05$.

be overweight/obese than those employees from the lowest end of the occupational hierarchy (OR 2.4 [95% CI 1.3–4.6]; $p = 0.008$). This finding contradicts the evidence from other higher income countries (Marmot et al., 1991) and previous Irish population based data (Morgan et al., 2008) but is similar to the overweight/obesity epidemic in lower income countries where it is associated with affluence and higher SES groups (Gupta et al., 2012; Martikainen et al., 2001).

Strengths and limitations

Although, caution must be observed when interpreting the findings of a cross-sectional study in a causal way, the findings of this study complement and are in accordance with the current literature pertaining to socio-economic inequalities in health; specifically when education was used as a marker of SES. It is the first piece of novel research to investigate the distribution of CVD risk factors in a specific group of employed adults in the ROI. Objective measurements of BMI, hypertension and height are the strength of this research; the ascertainment of these measurements did not rely on self-reported data. It has been suggested that individuals with an unhealthy BMI have a tendency to under-report their weight and height is usually overestimated by most people (Ziebland et al., 1996). It can be assumed that these measurements were not under or overestimated.

Some limitations need to be considered when interpreting the findings. Firstly, participants were recruited from four multi-national manufacturing companies in southern Ireland which would not be representative for the general population or the general working population. The 'healthy worker effect' is a common effect in studies with occupational samples and is reflected in the better health status of employed people relative to the general population as healthier workers are more likely to be selected into the work force and tend to stay longer in the workforce than individuals with poor health (Li and Sung, 1999). This may also be true for workers with a favourable cardiovascular risk profile, although research evidence on the applicability of the healthy worker effect to cardiovascular risk factors is lacking. Therefore the generalisability of the prevalence estimates of the cardiovascular risk factors to the general population may be limited. Also, comparing the findings to other international studies has to be approached with caution as education is a universal indicator for SES but it is measured differently across the world. Additionally, although employees were randomly selected to participate in the FCW study, those who agreed to participate may be systematically different to those who declined, introducing response bias to the data. However, demographic data on non-participants including gender and age showed that participants were similar to the general workforce (non-participants: 77.5% male (n = 314) and 70.4% aged 30–44 years (n = 285)). Finally, our measurement of blood pressure was limited by the fact that we did not have information on the current use of hypertensive medication. However this limitation was somewhat mitigated by the inclusion of participants with prior hypertension diagnosis as hypertensive. Nevertheless, we acknowledge that misclassification bias may have led to an underestimation of the prevalence of hypertension.

Conclusion

The findings from this study highlighted a number of issues that are relevant to the field of population health. Individual choices and physical factors (such as height) seem to be influenced by the wider social determinants of health (Link and Phelan, 1995; Morgan, 2006). Also, it was demonstrated that inequalities in some risk factors for CVD occur at each rank of the socio-economic hierarchy, not just at the point of severe deprivation (Adler et al., 1994; Marmot, 2005). Disparities in overweight or obesity and smoking have been highlighted in Irish population based studies (Morgan et al, 2008) but to our knowledge, this is the first study to highlight similar inequalities within a working population in the ROI. While it is not always feasible to compare population based studies to occupational studies (due to the 'healthy worker effect'), the evidence from this study can contribute to the existing evidence base that relates to the presence of social inequalities in working populations. Findings from this study suggested that managers were more likely to be overweight or obese compared to their socially lower counterparts. The mechanisms underlying this finding could be explored further. For example, the type of work that managers do maybe less physically demanding leading to a decrease in overall energy expenditure or perhaps managers have higher stress at work which may cause emotional eating. This study provides clear justification for further research to be carried out among the working population in the ROI. It is important to measure if these findings are also replicated in more diverse work settings (i.e. blue collar vs. white collar employees) to accurately inform future public health policy.

Finally, the World Health Organisation (2013) stated that the workplace has been established as a priority setting for health promotion as it can support the implementation of health promoting activities to large groups of people. Many individuals are now spending the majority of their waking hours at work (Chu et al., 2000). Therefore, findings from this research may assist in the critical identification of appropriate targets, which in turn can inform the development of effective workplace complex interventions to reduce socioeconomic inequalities in health.

Conflict of interest statement

The authors declare that there are no conflicts of interests.

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